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EFFECT OF IRON DEFICIENCY ON THE DEVELOPMENT AND PHYSIOLOGY OF MAIZE POLLEN[1]

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ABSTRACT

Maize (*Zea mays* L. var. Ganga 2) plants were raised in refined sand culture at normal (5.6 ppm) and deficient (1.12 ppm) iron supply. Study was made of pollen producing capacity, pollen grain size and *in vitro* germination of pollen grains and of activities of certain enzymes-catalase, peroxidase, cytochrome oxidase, acid phosphatase and invertase at five different stages of pollen development-tetrad to very young uninucleate microspores, binucleate vacuolated microspores, trinucleate immature pollen grains, mature pollen grains and freshly liberated pollen grains. Plants raised at 1.12 ppm iron supply developed mild chlorosis. These plants also showed decrease in the size of pollen grains, pollen producing capacity and activities of catalase and peroxidase in anthers.

INTRODUCTION

Lohnis (1937, 1940) reported poor development of anthers and pollen grains in boron deficient plants. Graham (1975, 1976) observed that copper deficiency in wheat resulted in abortive anthers and pollen grains even when plants did not exhibit visible symptoms of copper deficiency. More recently, Sharma *et. al.*, (1979) and Agarwala *et al.* (1979, 1980, 1980a) showed an involvement of copper, zinc, molybdenum and boron in the development and physiology of pollen grains. In this paper we describe the effects of iron deficiency on the development and activities of certain enzymes in anthers and pollen grains of maize.

MATERIALS AND METHODS

Maize (*Zea mays* L. variety Ganga 2) plants were grown at normal (5.6 ppm) and deficient (1.12 ppm) levels of iron supply and effect of iron deficiency was examined on flowering, pollen producing capacity of anthers, pollen grain size, *in vitro* germination of pollen grains in hanging drop culture. Activities of certain enzymes-catalase peroxidase, cytochrome coxidase, acid phosphatase and invertase were also determined. The enzyme activities were measured in anthers at four stages of pollen development *viz.* (I) tetrad to very young uninucleate microspores (II) binucleate vacuolated microspores (III) trinucleate immature pollen grains (IV) mature pollen grains and in (V)

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freshly liberated pollen grains as described earlier (Agarwala *et al.* 1979; Sharma *et al.*, 1979).

RESULTS

Plants grown at 1.12 ppm iron supply showed depression in growth and developed intervenal chlorosis of young leaves after three weeks. The intensity of chlorosis increased gradually. At the time of tasseling young leaves of iron deficient plants showed severe intervenal chlorosis.

Irrespective of iron supply, plants developed tessels at 7 weeks growth. Anthesis followed after another one week. Iron deficiency caused some decrease in size and pollen producing capacity of anthers but pollen grains of iron deficient plants were some what larger than the normal pollen grains.

With development starting from the tetrad stage to mature pollen grains there was a decrease in the activities of catalase and peroxidase and increase in the activities of acid phosphatase and invertase. Iron deficiency caused a decrease in the activities of catalase and peroxidase at all the stages of pollen development and decrease in the activity of invertase at later stages of pollen development. Activities of cytochrome oxidase and acid phosphatase did not show any definite trend in relation to iron supply.

TABLE I

EFFECT OF IRON DEFICIENCY ON LENGTH AND POLLEN PRODUCING CAPASITY OF ANTHERS AND SIZE AND VIABILITY OF POLLEN GRAINS OF MAIZE (*Zea Mays* L. VAR. G 2) PLANTS GROWN IN SAND CULTURE.

Iron supply (ppm)	Anther length* (mm)	Pollen producing* capacity (Pollen grains/anther)	Pollen diameter (μm)	Viability* (% *in vitro* germination)
5.6	5.5±0.06	2865±164	89.4±1.03 (250)	89.5±8.8
1.12	5.4±0.07	2780±188	91.2±1.32 (250)	82.0±9.6

* Mean of 10 determinations.

Values in parantheses are the number of pollen grains measured.

±Values represent the confidence interval.

TABLE II

EFFECT OF IRON DEFICIENCY ON THE ACTIVITIES OF CERTAIN ENZYMES IN THE ANTHERS AND POLLEN GRAINS OF MAIZE (*Zea mays* L. VAR. G2) PLANTS GROWN IN SAND CULTURE.

Iron supply (ppm)	Stage of Pollen development				
	I	II	III	IV	V
	CATALASE (μmoles H_2O_2 split/100mg fresh wt.)				
5.6	1200	1150	580	480	560
1.12	1175	750	480	310	420
	Peroxidase (Units/100 mg fresh wt.)				
5.6	107	90	108	50	39
1.12	106	96	73	39	21
	Cytochrome Oxidase ($\triangle$O.D./mt./100 mg fresh wt.)				
5.6	0.52	0.42	0.43	0.55	0.50
1.12	0.55	0.45	0.40	0.48	0.52
	Acid Phosphatase (μg/ Pi liberated /100 mg fresh wt.)				
5.6	131	171	500	525	525
1.12	156	130	460	545	505
	Invertase (mg invert sugars formed/100 mg fresh wt.)				
5.6	1.96	7.4	11.2	23.0	54.0
1.12	1.96	5.1	8.4	18.6	42.8

I—Tetrad to very young uninucleate microspores; II—Binucleate vacuolated microspores; III—Trinucleate immature pollen grains; IV—mature pollen grains and V—freshly liberated pollen grains.

DISCUSSION

Maize Plants grown at 1.12 ppm iron supply exhibited iron deficiency symptoms resembling these described by Agarwala and Sharma (1979) but, we did not observe any iron deficiency effect on the reproductive (anthers and pollen) development of plants. This is unlike the situation encountered under deficiency of molybdenum (Agarwala *et al.*, 1979) and boron (Agarwala *et al.*, 1980) wherein plants showing even mild foliar symptoms exhibit abnormalities in the development of anthers and pollen grains.

Observed activities of iron enzymes-catalase, peroxidase and cytochrome oxidase showed that, as in bacteria (Waring and Werkman, 1944) and vegetative tissues of higher plants (Agarwala *et al.*, 1977), in the anthers and pollen grains also, iron requirement of cytochrome oxidase was possibly met in preference to that of catalase and peroxidase. Decrease in the cata-

lase and peroxidase activities of iron deficient pollen grains, that showed near normal germination, lends support to the earlier observation (Agarwala *et al.*, 1979) that activities of oxidative enzymes may not always be indicative of pollen viability as suggested by some earlier workers (Stanley and Linskens 1974). But, as observed earlier in case of molybdenum and boron deficiencies in maize (Agarwala *et al.*, 1979; 1980), invertase activity of the pollen grains was low in iron deficient plants of maize.

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